BRUSA Elektronik AG
Neudorf 14
Postfach 55
CH - 9466 Sennwald

info@brusa.biz
www.brusa.biz
Tel. +41 81-758 19 00
Fax +41 81-758 19 99

DMC 524

User's Manual

Version 01

DMC524_Manual_V04.doc

Table of contents:

Specifications are subject to change without notice.

1 Before operation

Dear Customer!

With the BRUSA power inverter DMC524 you purchased a powerful and versatile product. To take advantage of its features and to avoid danger for man and material please read the operating instructions carefully before operating the unit. We recommend to keep the user's manual for later reference.

Changes to the user's manual are subject to further development of the device and won't be announced. Please download the latest version of this manual on: www.brusa.biz.

2 For Safe Use of this Unit

For your safety

- Read the manual carefully

- Please note that careless handling of high DC voltages can be very **dangerous** and **lethal**. So please take time to read the manual and connect the unit properly and call a skilled professional in any case.
- Note that lethal voltages exist around this unit. We cannot accept any liability concerning this danger.

- This unit produces waste heat. Touching the hot unit can lead to injuries and burnings. Please do not install easy flammable material close to the unit.

For your safety

- Have the unit installed and made operational by a skilled professional.
- Do not open the unit without contacting the manufacturer before.
- Do not connect the high voltage connector before being sure the device is separated from the high voltage DC-link (e.g.: in a vehicle by contactors).
- Never disconnect the high voltage connectors before being sure that there is no high voltage on the DC-link anymore.
- Use an insulation failure detector in order to monitor the galvanic insulation between any electrical contact and chassis.
- *Do not open the unit without contacting the manufacturer beforehand.*
- Never pull the battery plug out of the unit without breaking the HV connection beforehand

To prevent from damage of the device

- Ensure that for the high voltage circuit fuses or contactors are used in order to prevent the unit from damage in case of failure conditions
- Do not make any galvanic, electrical or low ohmic connection between any electrical contact, going out or coming from the DMC, to earth or chassis. This could destroy the DMC.
- Ensure sufficient cooling of the device. A low temperature of the cooling water has a considerable positive effect on the lifetime.
- Avoid operation of the device next to a heat source or in direct sunlight.
- Even though the high IP-protection, we recommend to not expose the unit to rain or splash water.

We cannot accept any liability for consequential damages which arose from the use of this device.

3 General Description

The DMC524 is a universal hardware inverter to drive a wide range of three-phase motors like induction motors, synchronous motors and hybrid synchronous motors.

The power stage of the DMC524 is based on the high performance and high efficiency SoftSwing® Topology invented by BRUSA Elektronik AG. This ensures very low switching losses and allows a real compact and lightweight design. In addition, EMC compliance can easily be achieved (no weight and volume of external filtering elements). The DMC524 is controlled by CAN. Status feedback in physical dimensions is provided too.

3.1 Features

- compact and lightweight: up to 15kW/kg
- Proprietary SoftSwing topology:
  - high efficiency and low EMI
  - fast and smooth regulation due to high PWM frequency
  - no degradation of motor isolation
  - high speed applications
- Control algorithms for AC induction and PM synchronous motors
- Torque, speed and power control
- CAN BUS and analog control interface
- Control supply from high voltage or 12V/24V auxiliary board supply
- Input and output common mode filters included
- Integrated cable box for easy installation

3.2 Applications

- Automotive drives for hybrid and fuel cell vehicles
- Hybrid bus traction or generator inverter
- Drives for Streetcars and Buses with overhead contact system
- Turbine applications (Turbo-generator, Compressor)
- High speed machining tools

4 Specifications

$T_{ambient}$=25°C, $T_{coolant}$=72°C, unless otherwise noted

Type	**DMC**	**524**	
Input DC Voltage (including HV supply voltage)			
Typical Input DC undervoltage shutdown			V
Minimum Input DC voltage for operation			V
Minimum Input DC voltage for full current capability	V_{DCmin}		V
Maximum Input DCvoltage for operation	V_{DCmax}		V
Typical Input DC overvoltage shutdown			V
Maximum Input DC surviving voltage			V
Three Phase AC Output			
Continuous RMS current	I_{ACcont}	225	A
repetitive max. RMS current 30sec 100%, 90sec 50%		300	A
Peak RMS current derating vs. $T_{coolant}$>72°C.		-6	A/°C
Cont. Power (V_{DC}=75%V_{DCmax}, I_{AC}=I_{ACcont}, cosφ=0,9)[1]	P_{ACcont}	80	kW
Max. Power (V_{DC}=75%V_{DCmax}, I_{AC}=I_{ACmax}, cosφ=0,9)[1]	P_{ACmax}	106	kW
PWM Frequency (symmetrical modulation)	f_{PWM}	24	kHz
Efficiency (V_{DC}=75%V_{DCmax}, P_{AC}=P_{ACcont}, cosφ=0,9)[1]		0.97	
Mechanical and Environment			
Height	h	88	mm
Width	w	240	mm
Length (without connections and cable clamps)	l	360	mm
Length (with connections and cable clamps)	l	386	mm
Weight (with cooling water)	m	9.2	kg
Coolant pressure drop @ 6l/min, $T_{coolant}$ = 25°C [2]		65	hPa
Power dissipation to coolant (I_{AC} = I_{ACcont})	P_{tot}	2.4	kW
Operational ambient temperature range		-40...+85	°C
protection grade		IP65	
Connections			
DC Input: 2 cable shoes M8; max cable cross section		70	mm^2
AC output: 3 cable shoes M8; max cable cross section		70	mm^2
23 pole AMP control connector, wire cross section		0.5	mm^2
Universal 14 pole Motor Sensor Interface connector			
recommended coolant hose inside diameter		14	mm

Note 1: 100% AC Sine Modulation, Phase-to-Phase AC Voltage amlitude = V_{DC}

Note 2: coolant = water / glycol, 50/50

5 Scope of delivery

Qty	description
1	inverter with software
1	manual of the inverter
1	CD with application software
5	crimp contacts for the power cables
5	washers for the crimp contacts
5	mounting screws for the crimp contacts
5	screwed cable glands for the power cables
1	special tool for the screwed cable glands
1	AMP connector with 25 pins
5	closing plugs for the cable glands
2	closing plugs for the water connections

A complete set to run the inverter:

- Inverter DMC524

- *mounting screws for the crimp contacts*
- *washers for the crimp contacts*

- *screwed cable glands for the power cables*

- *special tool for the screwed cable glands*

- *crimp contacts for the power cables*

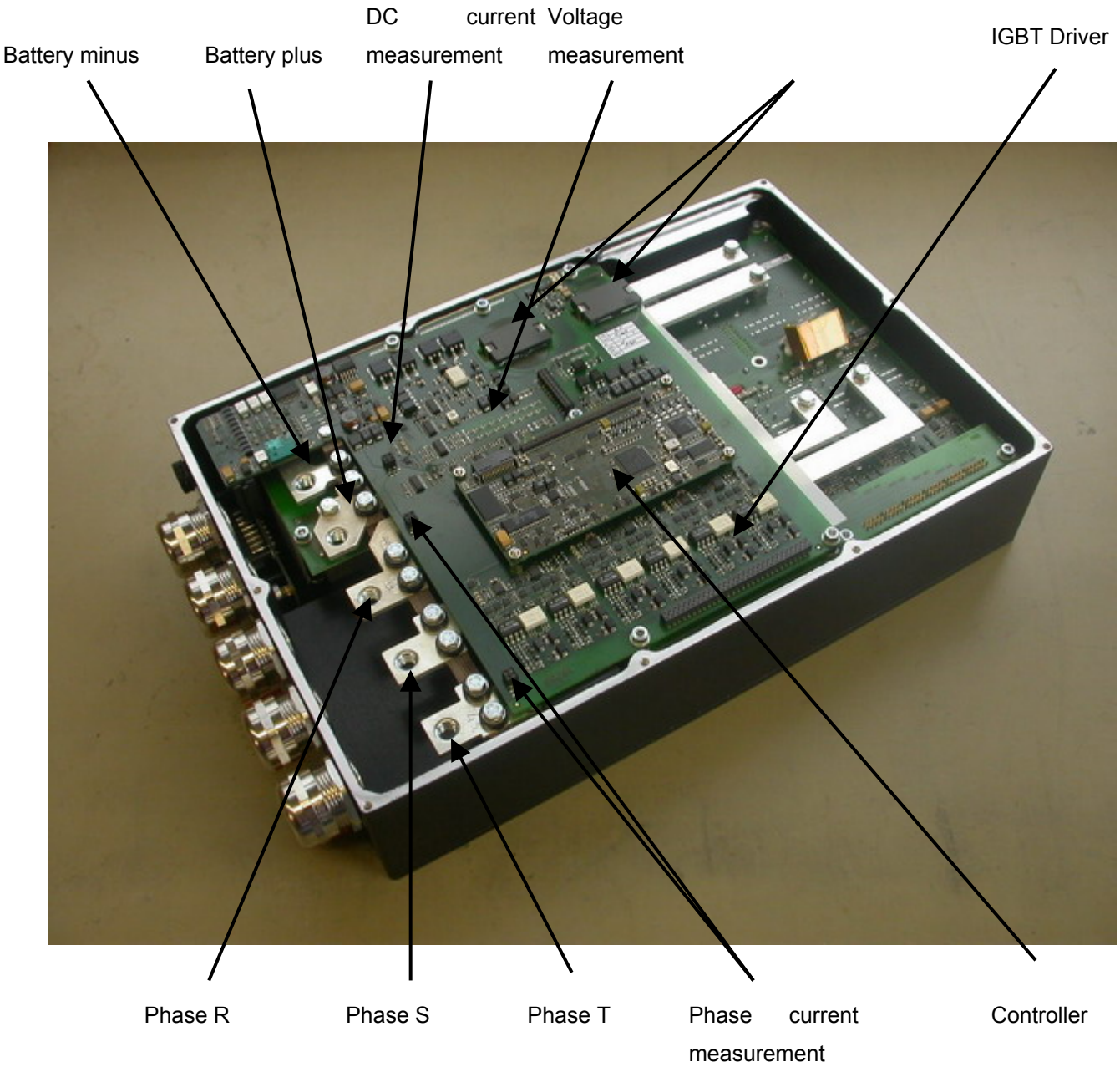
- *closing plugs for the cable glands*

- *closing plugs for the water connections*

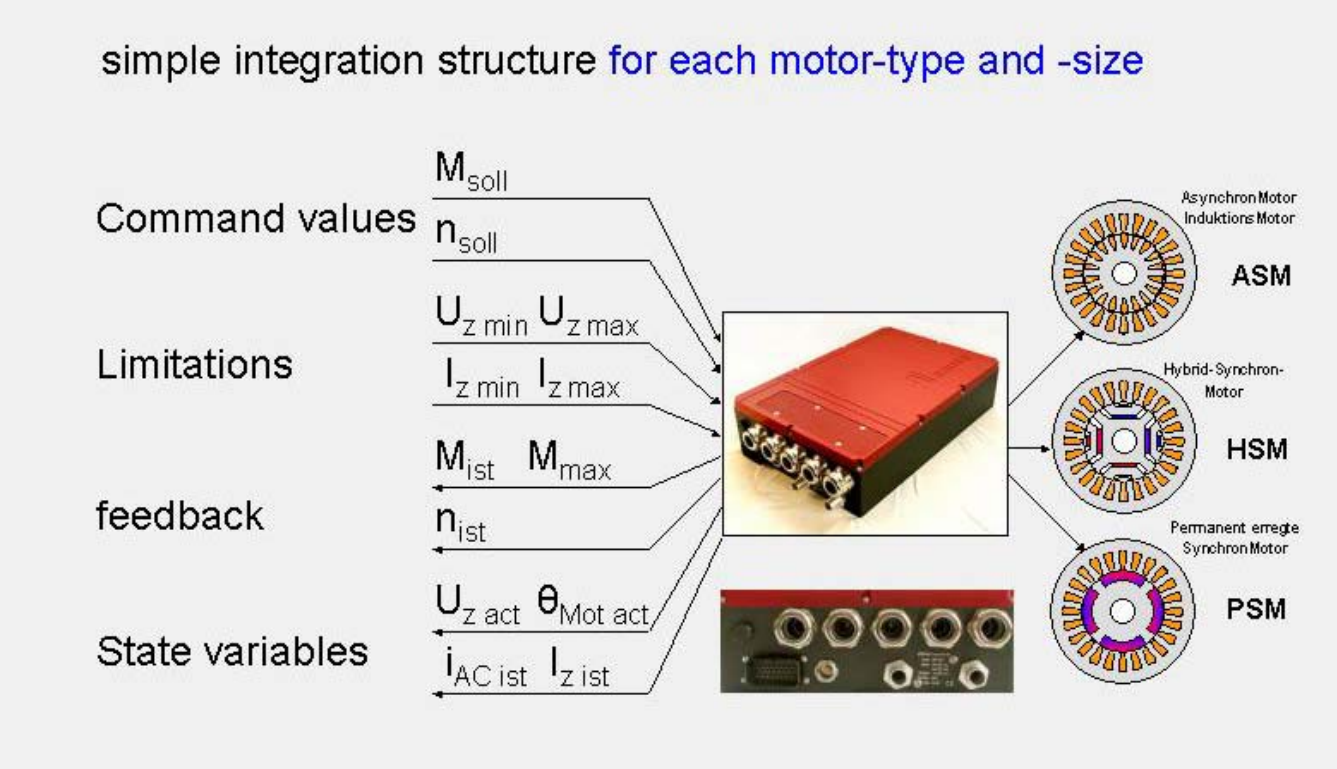
- 23-pole control connector with crimp contacts:
- *AMPSEAL socket: 770680-1*
- *AMPSEAL contacts: 770854-1*
- *Wire size: 0.5mm^2*

6 Overview

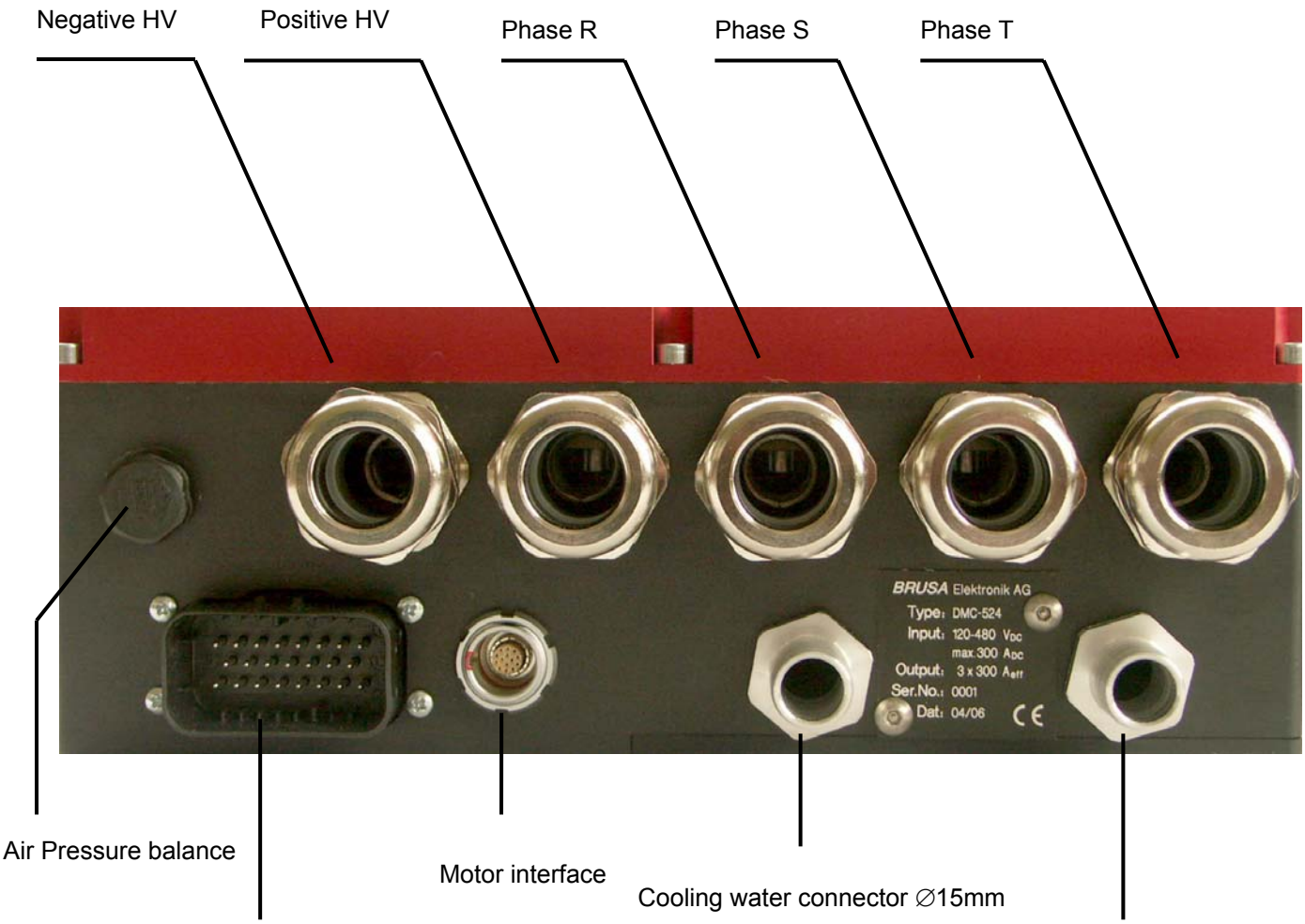
With opened cover, the DMC524 contains following parts:



6.1 Functional Overview

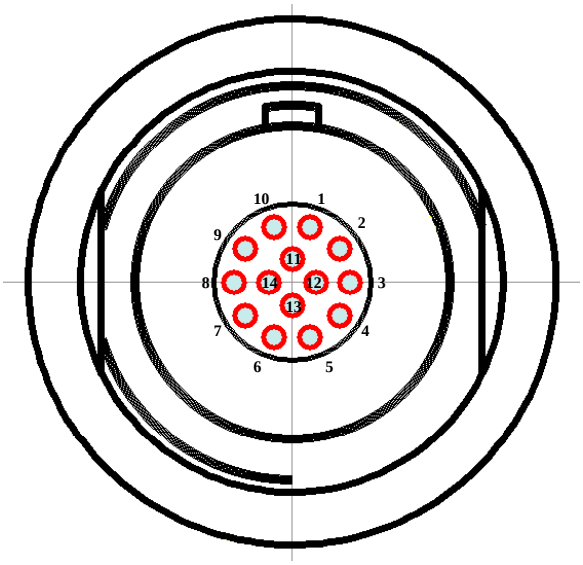


7 Connectors



7.1 Motor Interface (RPS048)

Plug out:



7.1.1 Pin assignment:

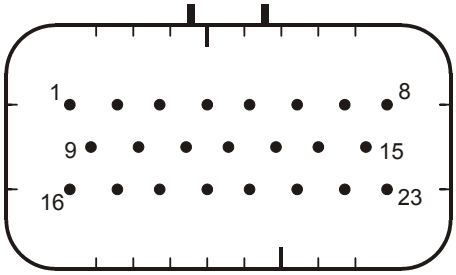
Pin	Def.	Function	Color
1	POS3	6-BIT Absolute Position	brown
2	POS4	6-BIT Absolute Position	red
3	POS5	6-BIT Absolute Position	pink
4	GND	Ground Position Sensor	yellow
5	NTC	Motor NTC temperature sensor	green
6	PTC	Motor high temperature switch	blue
7	5V DC	Motor interface supply 5VDC	violet

Pin	Def.	Function	Color
8	POS0	6-BIT Absolute Position	gray
9	POS1	6-BIT Absolute Position	white
10	POS2	6-BIT Absolute Position	black
11	GND	Ground NTC / PTC	brown green
12	MOT B	Motor sync signal B (incremental)	red blue
13	MOT A	Motor sync signal A (incremental)	pink gray
14	UPD	Position Update Signal	yellow brown

The 5VDC (Pin 7) are only present, if HV (high voltage, battery terminals>130VDC) is present at the DMC, that means, the speed sensor or position sensor is only powered, when high voltage is supplied.

7.2 CAN Bus and Control Interface

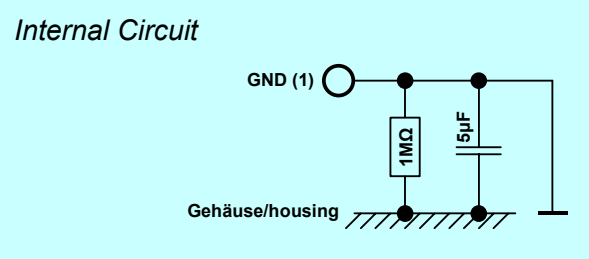
7.2.1 Control connector (23-pole):



No.	Abbr.	Function
1	GND	Ground (Auxiliary voltage minus, clamp 31, not connected to the case!)
2	AUX	+12V (+8V..+32VDC, auxiliary voltage plus, clamp 30)
3	EN	Power Enable (Power ON), active high
4	DO0	Digital Output 1 (programmable)
5	DO1	Digital Output 2 (programmable)
6	DO2	Digital Output 3 (programmable)
7	DO3	Digital Output 4 (programmable)
8	PG1	Analog Protected Ground (for pins 20 – 23)
9	CNL	CAN low
10	CNH	CAN high
11	TXD	RS232 Transmit (9-pole D-Sub: Pin 2)
12	RXD	RS232 Receive (9-pole D-Sub: Pin 3)
13	PRO	Enable firmware download
14	PG2	CAN Protected Ground
15	PG3	RS232 Protected Ground (9-pole D-Sub: Pin 5)
16	DI0	Digital Input 0
17	DI1	Digital Input 1
18	DI2	Digital Input 2
19	IL1	Interlock Pin 1
20	IL2	Interlock Pin 2
21	AI1	Analog Input 1 (programmable)
22	AI2	Analog Input 2 (programmable)
23	AI3	Analog Input 3 (programmable)

7.2.2 Description of the Control Connectorpins

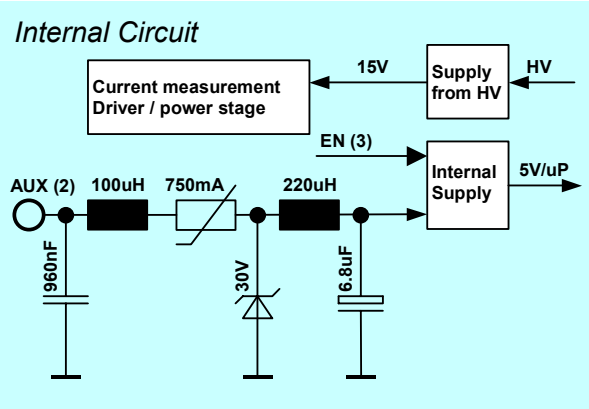
7.2.2.1 GND (Ground), Pin 1



- Direct connection to control unit ground .
- Capacitive coupling to case only.

- If DMC524 control signals are connected to other vehicle components (e.g. propulsion system, on-board battery, battery management system, fuel cell) the vehicle's ground must be connected to this terminal.

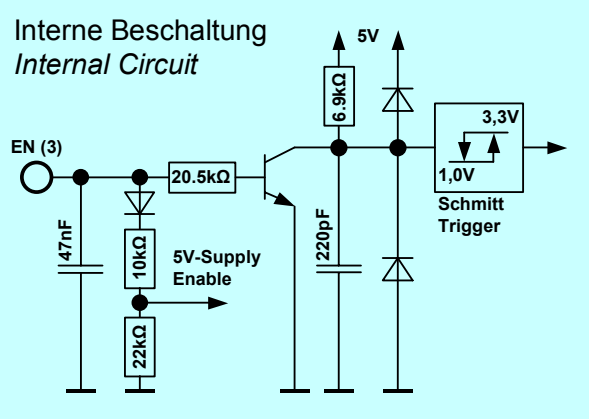
7.2.2.2 AUX (Auxiliary Supply), Pin 2



- The CAN communication, RS232 communication, firmware programmability of the microprocessor and the possibility to measure the voltages and temperatures is established by the internal 5V supply. This supply is only fed by the AUX (+12V) input. The DMC can't work only by supplying by HV (high voltage terminals)
- Input current I_AUX at 12V-auxiliary supply:

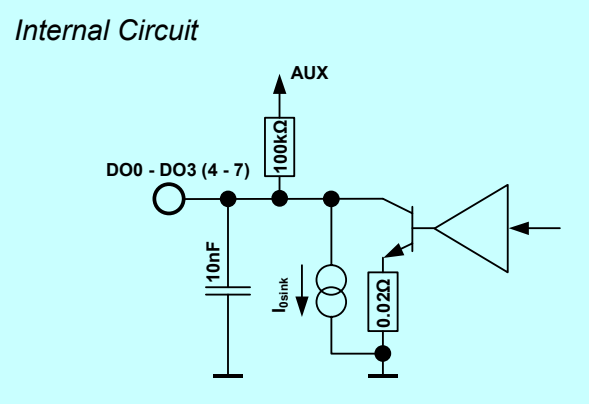
- *EN = „L": 29mA*
- EN = „H": 42mA
- If HV is also applied and high enough (>120V) and no error is detected, the device is fully ready to operate (current measurement active, driver and power stage active).

7.2.2.3 EN (Enable, Power ON), Pin 3



- By applying a voltage to **AUX** and by setting **EN** = „high“ (+5V...32V) the device will be ready to operate. Reasonably this is realized by using a switch in order to connect the enable-pin to the auxiliary supply.
- If additionally high voltage is applied to the power interface, the device is fully ready to operate and can be turned on and operated by sending appropriate CAN-messages.
- Otherwise a limited operation is possible as further explained in the description of pin **AUX**.
- In order to download a new firmware, **EN** does not have to be „high”.

7.2.2.4 DO0 – DO3 (Digital Outputs), Pins 3 - 7



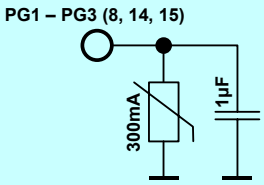
- With these four programmable digital outputs, low frequency applications can be realized:
- Drive LEDs for status functions (e.g.: under- or overvoltage, exceeding of current limit, temperature derating,...).
- Drive other external components (PWM for display instruments, relays, small fans,...).
- All four digital outputs show the following features:

- *Short circuit detection (Imax = 700mA).*
- *Over-temperature shutdown.*
- *Open load detection (by current source).*
- *Independent detection of each of these failures and providing of fault signal (e.g.: feedback to the processor).*

- In case of such a failure at one of the outputs the other outputs remain still fully functional as long as such a failure does not lead to over-temperature shut down of the other outputs.
- All outputs can be driven with a frequency up to 1kHz.

7.2.2.5 PG1 – PG3 (Analog Ground), Pins 8, 14, 15

Internal Circuit

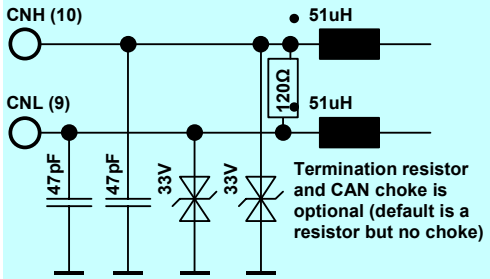


- In order to simplify external wiring, three additional ground pins are available. Each pin is connected to the supply's ground **GND** by a PTC-fuse.
- Following pin assignment is suggested:

Nr.	*Abbr.*	*Function*
8	*PG1*	*Analog Protected Ground (for pins 20 - 23) (protected means with fuse)*
14	*PG2*	*Protected Ground (protected means with fuse)* *CAN-GND*
15	*PG3*	*Protected RS232 Ground (9-pol D-Sub: Pin 5, protected means with fuse)*

7.2.2.6 CNH, CNL (CAN-Bus, CAN-Interface), Pins 9, 10

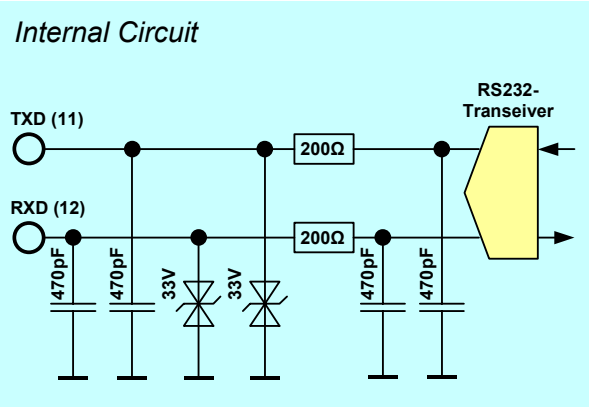
Internal Circuit



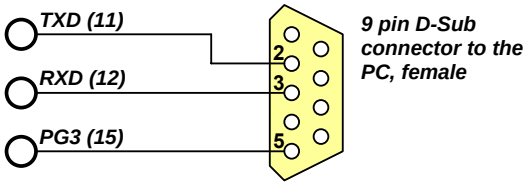
The CAN interface has following characteristics:

- CAN 2.0 B, 500 kBaud
- Galvanic insulation from ground and all other control signals in order to avoid interferences caused by ground offset voltages.
- The 120Ω termination resistor can be mounted optionally.
- The CAN interface allows to transmit and receive messages according to the CAN-matrix defined by the customer.

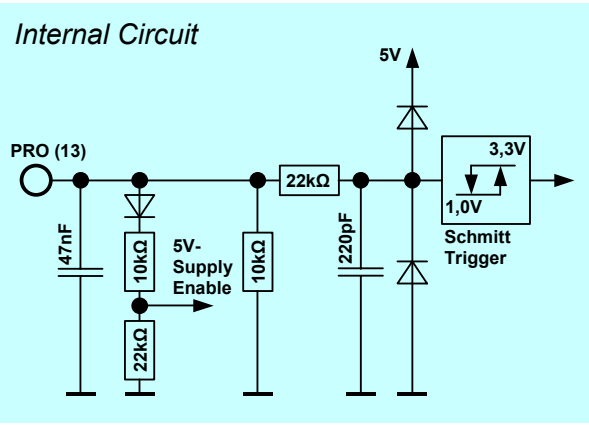
7.2.2.7 TXD, RXD (RS232-Interface), Pins 11, 12



- *The RS232 interface provides a direct serial connection between the DMC524 and a computer. You can use the standard Windows Hyperterminal tool on the computer e.g. at COM1 and configure it to 19'200bits/sec, 8 bits, no parity, 1 stop bit and no protocol in the hyperterminal. This connection is not intended for general use. Please contact Brusa Elektronik AG (office@brusa.biz) for further informations.*
- *You can also download firmware via these pin's for the microprocessor, which is provided by BRUSA Elektronik AG (by setting PRO = "high"). For further information regarding the download, please contact directly BRUSA Elektronik AG. The download of a new firmware may also only be done with agreement of BRUSA Elektronik AG.*
- *Pin assignment of the 9-pole D-sub socket:*



7.2.2.8 PRO (Enable firmware download), Pin 13

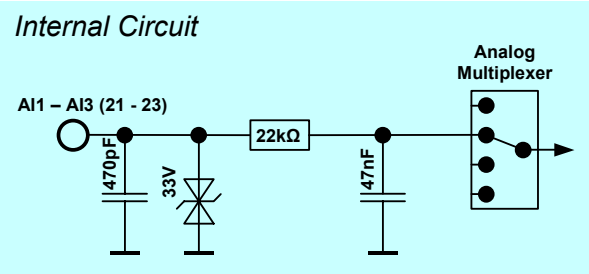


- This pin is exclusively activated (**PRO** = „high") to download a new firmware, whereas **EN** does not have to be „high".
- **PRO** = „high" causes the following actions regardless of supplying the device from HV or auxiliary supply:
- *If the device is in operation, it will be shut down.*
- *The device is then ready to be programmed via the serial interface.*
- The download of a new firmware may only be done with agreement of **BRUSA Elektronik AG**. The new firmware could be sent by email.

7.2.2.9 DI0 – DI2 (Digital Inputs), Pins 16 – 18

- With these three inputs, various functions can be realized by firmware upgrade and the needs of the customer.

7.2.2.10 AI1 – AI3 (Analog Inputs), Pins 21 – 23



- With each of these three analog inputs two different functions can be realized:

- *1mA – current source for an external 5kΩ potentiometer*
- *33kΩ Pull-up – resistor for external 33kΩ NTC-temperature sensor.*

- Each of these three analog inputs can be programmed individually according to the customer's requirements. If all three inputs are configured as current source, the following functions could be realized:

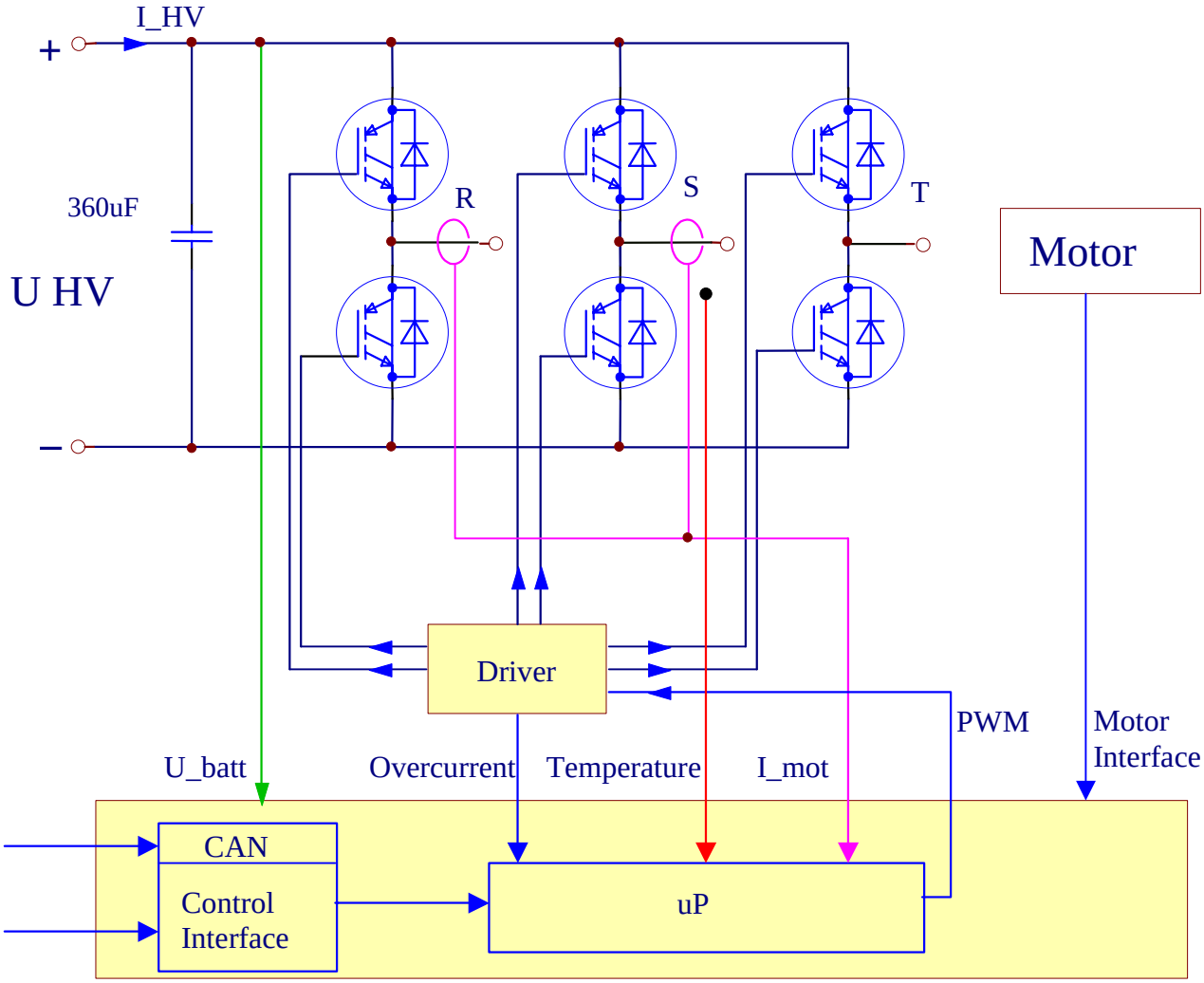
- *AI1: Voltage limit*
- *AI2: Current limit*
- *AI3: Reserve*

- If the inputs are configured for temperature measurement (T_{min} = 25°C) of external components, the following configuration can used:

- *AI1: Battery temperature*
- *AI2: Cooling water temperature*
- *AI3: Reserve*

8 Overview

8.1 Block Diagram

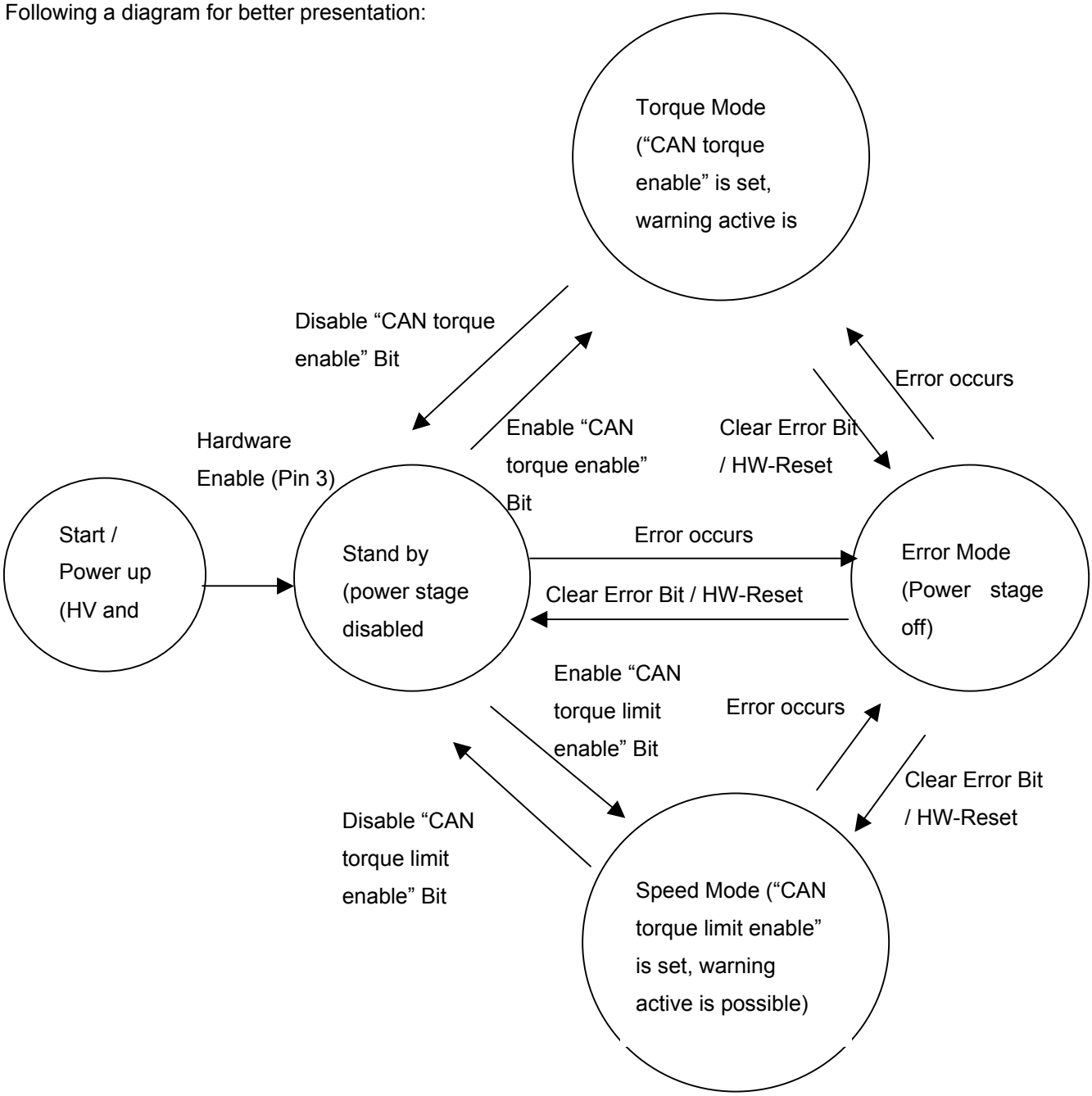


9 General

9.1 Field of Application

In this section, there will be explained the general function modes of the DMC, e.g. the different regulator modes, the error mode and as a consequence, the different reactions to it.

Following a diagram for better presentation:



9.2 Stand by Mode, Normal Operation, Supply

See description at AUX (Auxiliary Supply), Pin 2 and at EN (Enable), Pin3 (page 16), which refer exactly to that point in detail.

9.3 Regulator Modes

If no Torque Mode or Speed Mode is selected, the DMC is in stand by mode. The power stage is disabled.

9.3.1 Torque Mode

The main regulator is the torque regulator. You can choose the torque command value by CAN in the maximum possible range, the DMC tries to reach this torque, if no limitations are active (warning).
It is possible, that the torque can be limited by a to high temperature of the motor or the inverter, by a to low (motoring) or high (regeneration) battery voltage (HV), by a to high HV current, by a to high motor current, by a to high speed. This controller will not work in this mode, if an error is active (error message on CAN).

- Pay attention, if the motor has no load and you want command a high torque. The motor will accelerate very fast until it reaches the maximum allowed speed (e.g. 30'000rpm or 100'000rpm).

9.3.2 Speed Mode *(formerly torque limit mode)*

The main regulator is the speed regulator. The negative or positive torque can simultaneously be limited/reduced, so that the risk of an undesired condition is minimized. The DMC tries to follow to the desired speed with this limited torque.
It is even possible, that the desired operating point can't be reached due to a limitation of other regulators (warning) or even completely disabled (error). The reason for reduction could be a to high temperature of the motor or inverter, to high motor or battery current, a to low (motoring) or to high (regeneration) HV voltage.
The inverter will not work in this mode, if an error is active (error message on CAN) => error mode.

9.4 Error and Warning Modes

9.4.1 Error definition

Errors will result in full performance loss, which will cause the system to shut down without recovering performance. The error will be latched and can only be cleared by the CAN-command bit "clear error" or by hardware reset. For further details please refer to the valid CAN-Matrix.

9.4.1.1 Short Circuit / Error

If a short circuit for more than 16 times during 2 seconds is detected from the drivers at the power stage, the power stage will be switched off permanently and the error_bitmap will be set (Gate unit, "short circuit condition" at message 0x25A, Byte 0, Bit7)
If there are less than 16 short circuits during 2 seconds, the power stage will be switched off only for 50ms.

9.4.2 Warning Definition

Warnings may cause reduction of performance by internal DMC situations (inverter temperature) or loss of performance caused by external interface (e.g. undervoltage, loss of communication etc.) .Warnings will not be latched and full performance can be restored, when warning condition is corrected. Error and warning status are updated in periodic CAN-messages.

9.5 Safety Line

Output from DMC:

If the “Main contactor request Pin” Bit at the CAN message 0x210 (CMS_B_MC_REQ) is set, the safety line (Pin 5 at Control Interface) is pulled down (active low), otherwise it is free and can be pulled down also by other devices connected to the safety line.

Input:

If LOW (active low) is detected on the safety line (Pin 5 at Control Interface), the DMC sets the Bit “Pin Main contactor request” Bit at the CAN message 0x258 (CMS_B_MC_PIN).

In any case, if the safety line is low, the DMC switches off the power stage. This condition can also happen, if another device connected to the safety line has detected a fault and have pulled down this safety line.

9.6 DMC524 Firmware Update

The firmware of the DMC524 can be updated in order to use additional features that have been implemented after the initial production date of the inverter. For this task, a firmware flash loader program is used which is described here and is available from the web-site:

http://www.renesas.com/fmwk.jsp?cnt=/download_search_results.jsp&fp=/support/downloads/download_results&layerId=1050

Caution: Before updating the firmware, make sure that no conflicts occur with your current setup. If you are not sure about it, please contact BRUSA Elektronik AG or your local dealer. The Motor Parameter Table could be newer and not compatible with the old one. Especially the custom specific motor types could be not usable anymore.

9.6.1 Requirements

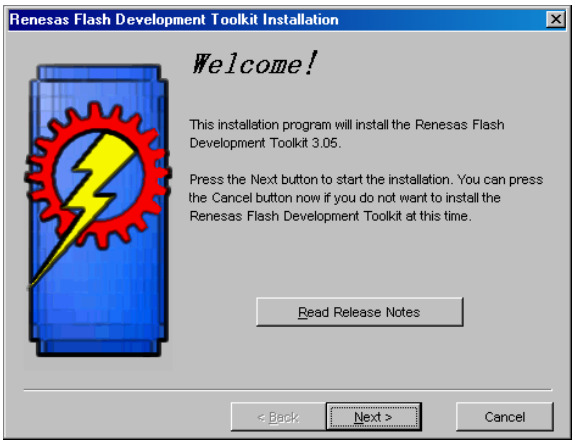
- PC running Windows 95 / 98 / NT / 2000 / XP
- Serial interface RS232

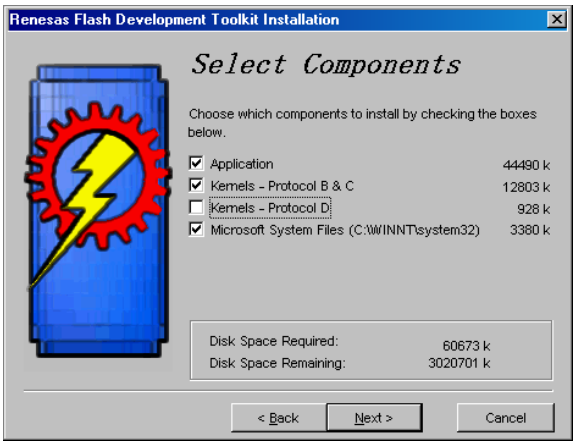
9.6.2 Setup of DMC524 and PC

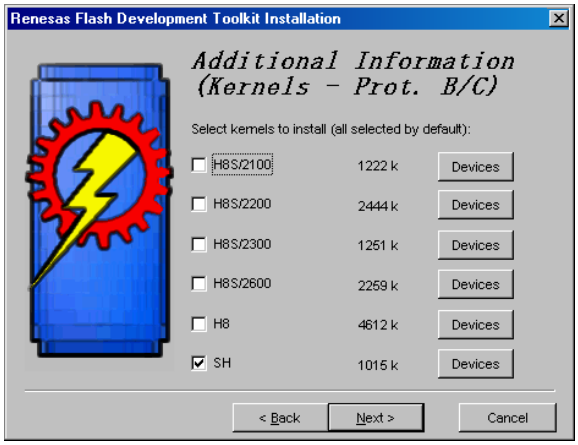
- Connect pin 13 (PRO) of the DMC524's 23-pin control connector to pin 2 (AUX).
- Power up the DMC524 through AUX 12VDC.
- Connect the RS 232 cable to the serial interface COM1 of the PC and to the appropriate pins of the DMC524's control connector (see 7.2.2.7, TXD, RXD (RS232-Interface), Pins 11, 12).
- Make sure that no other application uses or tries to use the COM1 serial interface.

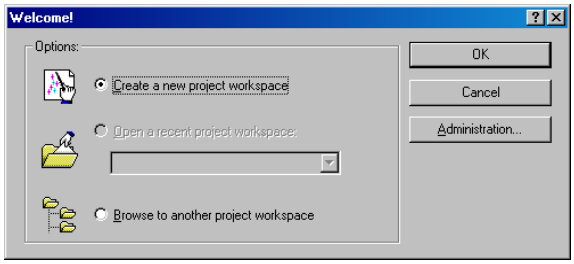
9.6.3 Installation of the Flash Loader Program

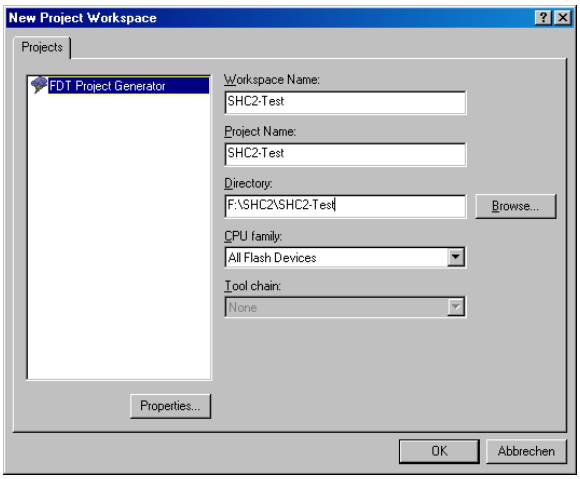
In order to download the new firmware to the DMC524 the DMC5 the „Flash Development Toolkit FDT305“ have to be installed as follows (installation steps which are not listed below nothing was modified and you have to click the Next-Button):

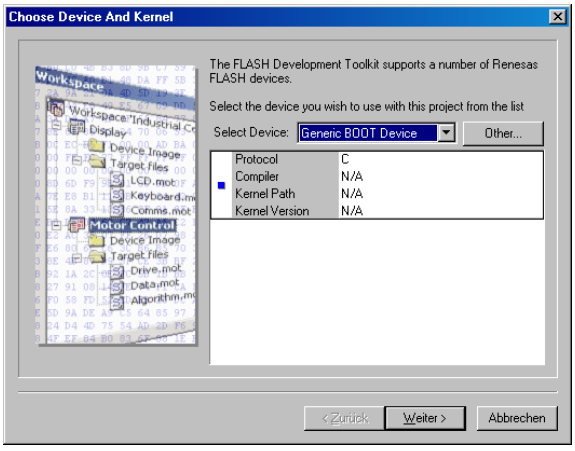


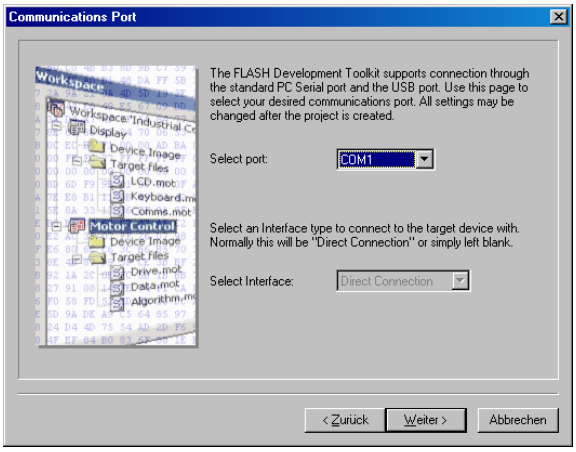




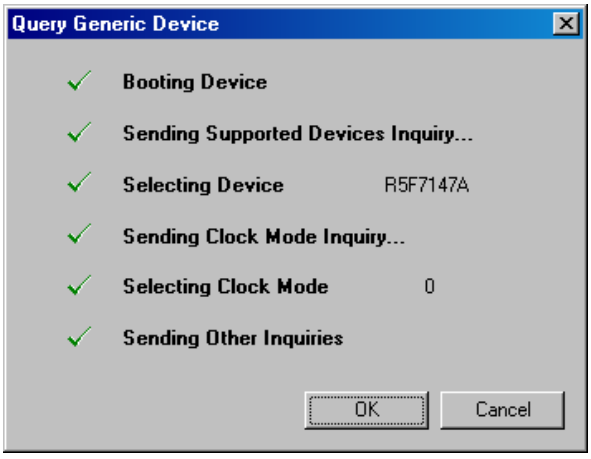


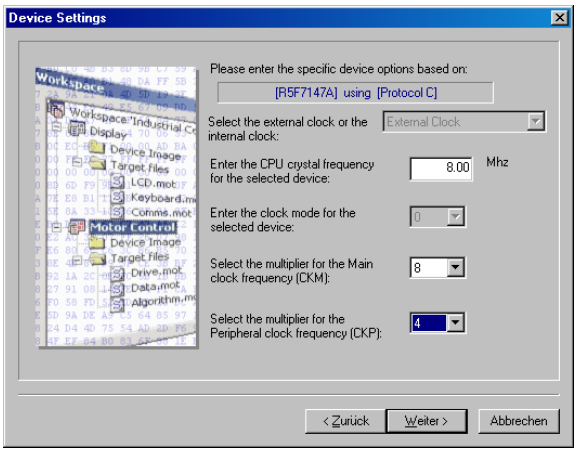


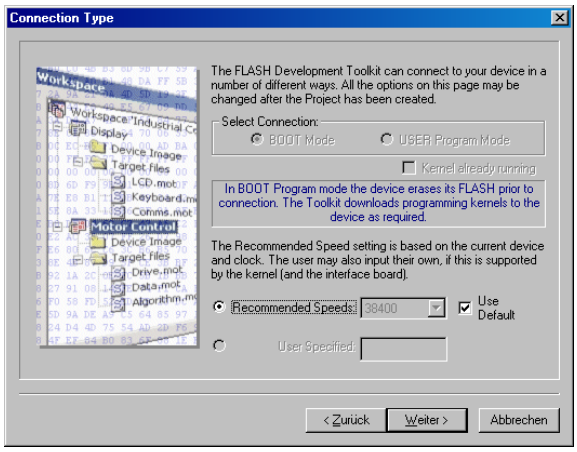


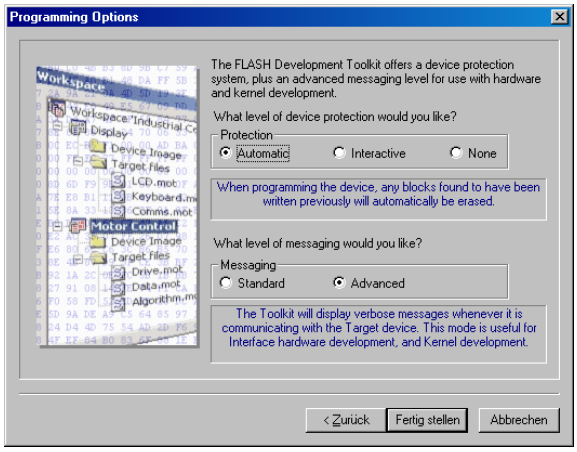


- **Attention: Before clicking „OK“ a Reset have to be executed.**

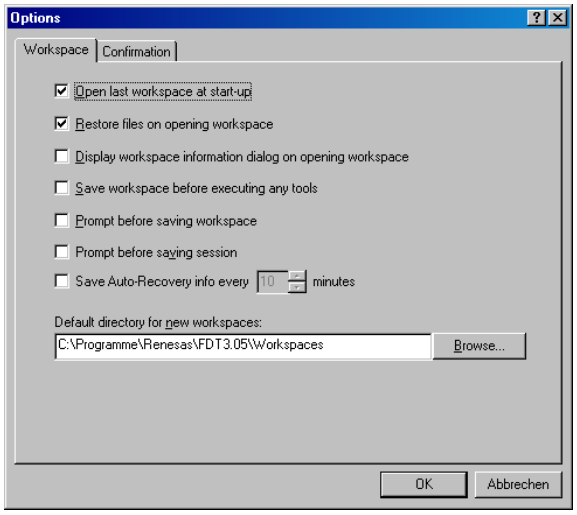


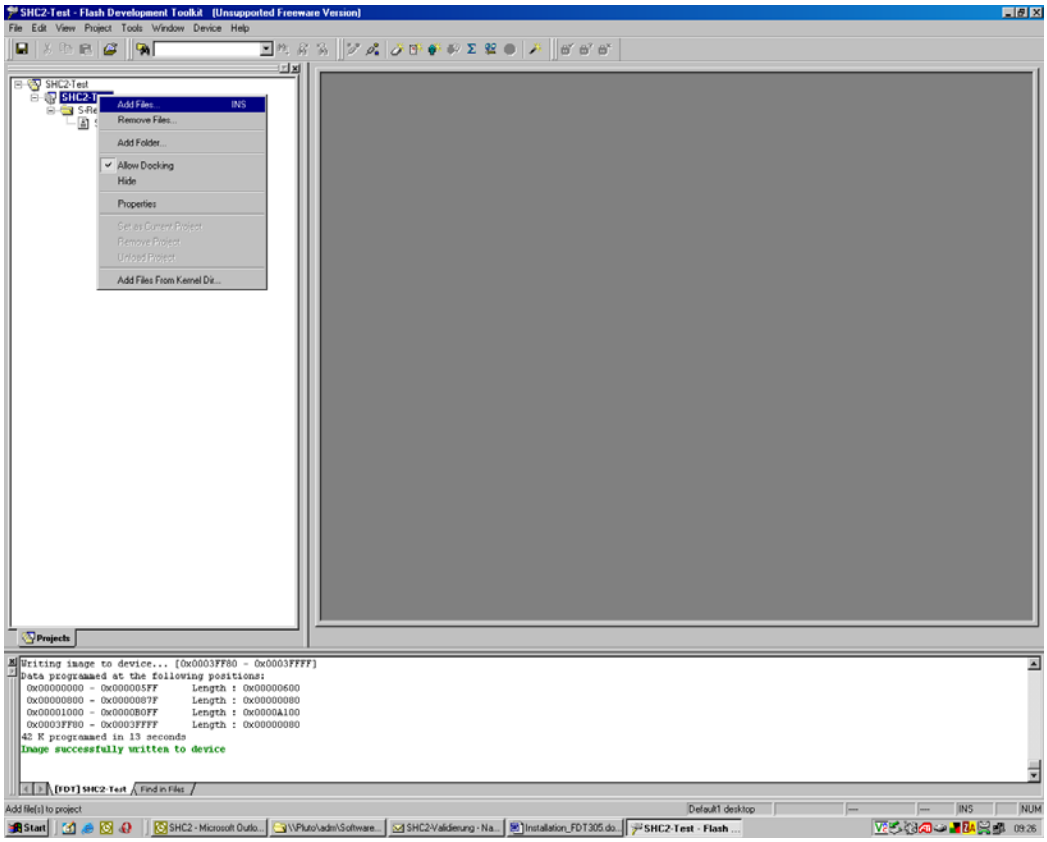






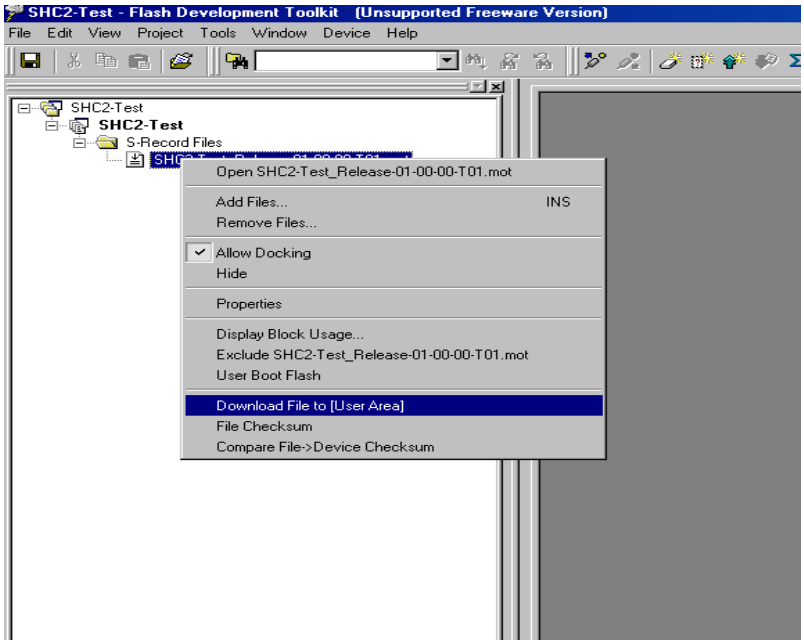
➢ Tools/Options:





- Switch on the “Prog-On” switch

- programming the DMC524:



10 CAN Bus Protocol

10.1 Data Format and Range Definitions

Data order, as sent in a message: Bit 15...7...0 = MSB...LSB, Byte 0 ... Byte 7, high byte in a word first, high word in a Long first (Motorola convention).

Used data types in this document are bits, bitmaps (bit length: 8 or 16) and analog signals (signed word). Bits are first assembled to bitmaps, before there location in the message will be placed.

Every analog value has a valid range, in which the receiving controller shall not have any data format problems. The receiving controller checks the data, if it is in the valid range.

If data is out of range, the corresponding error bit will be set and appropriate error action will be taken. Analog status values of the lower controller will have a defined no valid value which shall be used for sensor breakdown or other events to indicate to the upper controller that the value is not valid and that a default value should be used.

10.2 Error and Warning Definitions & Handling

10.2.1 Error Definition:

Errors will result in full performance loss, which will cause the system to shut down without recovering performance by itself. The error is latched and can just be cleared by the a command bit or a hardware reset.

10.2.2 Error List

Error Name	Hex Code	Byte No. / Bit No. in CAN Message	Description:
ERROR_INIT	0x8000	byte0 - bit7	set, if offset current at hall sensors at ignition 15 start up is bigger than +- 10A
ERROR_DC_OVERCURRENT	0x4000	byte0 - bit6	set, if I bat > 370A (only active after init routine)
ERROR_DC_OVERVOLTAGE	0x2000	byte0 - bit5	set, if U bat > 445V (420V at CAN Matrix Version 1.5 and earlier)
ERROR_DC_UNDERVOLTAGE	0x1000	byte0 - bit4	set, if U bat < 130V
ERROR_SEVERE_OVERSPEED	0x0800	byte0 - bit3	set, if n_act>92000rpm or n_act<-92000rpm values coming from motor parameter

			table (set also, if speed sensor cable is not connected, because speed is set to 123'456U/min in that case)
ERROR_SEVERE_OVERTEMP_MOTOR	0x0400	byte0 - bit2	set, if temperature specific PTC overtemperature sensor at motor measures to hot temperature (e.g. coil at 180°C to the inverter, no software adjustment possible)
ERROR_SEVERE_OVERTEMP_INVERTER	0x0200	byte0 - bit1	set, if temperature at power stage > 110°C
ERROR_CAN_MSG_MAIN_COMMAND	0x0100	byte0 - bit0	set, if CAN message receive time > 40ms
ERROR_SHORT_CIRCUIT_INVERTER	0x0080	byte1 - bit7	Set, if during 2 sec. more than 16 short circuits were counted from power part. If there are less than 16 short circuits during 2 seconds, the power stage will be switched off only for 50ms.
ERROR_MSG1_LOST		byte1 – bit4	bei Fehlen der CAN-Verbindung wird ein Error ausgelöst
ERROR_MSG2_LOST		byte1 – bit5	bei Fehlen der CAN-Verbindung wird ein Error ausgelöst
ERROR_COMMAND_OUT_OF_RANGE_MSG1	0x0040	byte1 – bit0	Set, if some CAN Message in “DMC Torque Control” leaves the valid range given in the CAN-Matrix
ERROR_COMMAND_OUT_OF_RANGE_MSG2	0x0020	byte1 – bit1	Set, if some CAN Message in “DMC DC Limits” leaves the valid range given in the CAN-Matrix
ERROR_UBATT_REDUNDANCY	0x0040	byte1 - bit6	Set, if a difference bigger than 15 volts is measured between the two HV voltage sensors (redundancy) during 17.06ms

10.2.3 Warning Definition

Warnings may cause loss of performance caused by external interface (e.g. undervoltage, loss of communication etc.) or internal DMC situations (inverter temperature).
Warnings will not be latched and full performance can be restored, when warning condition is corrected.

10.2.4 Warning Description

Error Name	**Hex Code**	**Byte No. / Bit No. in CAN Message**	**Description:**
WARNING_LIMIT_BY_DC_CURRENT	0x8000	byte2 - bit7	Set, if torque is limited by one of two HV DC Current limits (e.g. “DC Current Limit Motoring” and “DC Current Limit Regenerating”)
WARNING_LIMIT_BY_DC_VOLTAGE	0x4000	byte2 - bit6	Set, if torque is limited by one of two 2 HV DC Voltage Limits (e.g. “Motoring DC Voltage Limit” and “Regenerating DC Voltage Limit”)
WARNING_LIMIT_BY_SPEED	0x2000	byte2 - bit5	Set, if torque is limited by speed (“Speed Request”)
WARNING_LIMIT_BY_MOTOR_TEMP	0x1000	byte2 - bit4	Set, if torque is limited by Motor Temperature, determined by **Fehler! Verweisquelle konnte nicht gefunden werden.**, **Fehler! Verweisquelle konnte nicht gefunden werden.** (”Tm” and “kT”)
WARNING_LIMIT_BY_INVERTER_TEMP	0x0800	byte2 - bit3	Set, if torque is limited by Inverter Temperature, please see also 12.2, Electronic Data or 12.3.1, Output current

WARNING_COMMAND_OUT_OF_RANGE	0x0200	byte2 - bit1	Set, if some CAN Message leaves the valid range given in the CAN-Matrix
WARNING_LIMIT_BY_AC_CURRENT	0x0080	byte3 - bit7	Set, if torque is limited by AC current, determined by **Fehler! Verweisquelle konnte nicht gefunden werden.**, **Fehler! Verweisquelle konnte nicht gefunden werden.** (”mc” and “gc”)

10.2.5 Torque Control List

Error Name	**Hex Code**	**Byte No. / Bit No. in CAN Message**	**Description:**
MAIN_CONTACTOR_REQUEST	0x8000	byte1 - bit7	0 = Closing allowed, 1 = Open contactor request
GENERAL_ERROR_LATCH	0x0200	byte1 - bit1	0 = No Error, 1 = Error/failure latched
GENERAL_WARNING	0x0100	byte1 - bit0	0 = No Warning, 1 = Warning active at the moment
TORQUE_LIMIT_DC_CURRENT	0x0080	byte0 - bit7	1 = Torque is limited by DC current at the moment
TORQUE_LIMIT_DC_VOLTAGE	0x0040	byte0 - bit6	1 = Torque is limited by DC voltage at the moment
TORQUE_LIMIT_SPEED	0x0020	byte0 - bit5	1 = Torque is limited by speed at the moment
TORQUE_LIMIT_TEMPERATURE	0x0010	byte0 - bit4	1 = Torque is limited by some temperature at the moment
TORQUE_LIMIT_AC_CURRENT	0x0008	byte0 - bit3	1 = Torque is limited by AC current at the moment

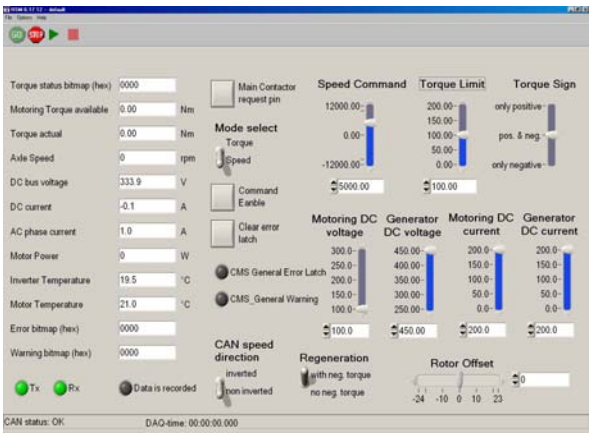
10.3 Can Bus Commands

10.3.1 Version: DMC5_CAN_Spec_3.0.xls:

Views			Naming		Loc.				Definition				
Default Sortierung	Level	Rx, Tx (for DMC)	Message Name	Short Name [max. 8 char]	Used in CAN Bus	ID		DLC		Transmit Time* [ms]	Max. Delay time [ms]	Msg Loss Time* [ms]	No message after init
			Analog Signal / Bitmap Name	Short Name [max. 12 char]	Used in Message	Start Byte	Start Bit	Byte Length	Valid range (physical)	Resolution	Unit	Sign Definitions	Default / Init Value
			Bit Name	Short Name [max. 12 char]	Used in Bitmap	Start Byte	Start Bit	Bit Length	Value Definition				Default / Init Value
			Filters										
1.0	Msg	Rx	DMC Torque Control	DMC_CTL	VBUS	0x210 (0x208)		8		10	3	40	No Operation
2.0	Sig	Rx	DMC Control Bitmap	DMC_CTLB	DMC_CTL	0	0	1					0
3.0	Bit	Rx	Enable Request	DMC_ENABLE_REQ	DMC_CTLB	0	7	1	0 = Power Stage disabled, 1= Power Stage requested to enable				0
3.5	Bit	Rx	Torque Mode	DMC_MODE_REQ	DMC_CTLB	0	6	1	0 = torque mode, 1 = speed mode				0
4.0	Bit	Rx	Enable Regeneration	DMC_B_REGEN_EN	DMC_CTLB	0	5	1	0 = Disable, 1 = Enable				0
4.3	Bit	Rx	CAN speed direction control	DMC_B_DIR_CTRL	DMC_CTLB	0	4	1	0= non inverted (nomal operation), 1= inverted				0
4.5	Bit	Rx	Clear error latch	DMC_B_CLRERR	DMC_CTLB	0	3	1	0->1 = Clear error latch				0
4.8	Bit	Rx	dummy	dummy	DMC_CTLB	0	2	1					0
5.0	Bit	Rx	Neg_Torque or Speed	DMC_NEQ_TRQ_OR_SPD	DMC_CTLB	0	1	1	if torque mode enabled: 0= negative speed is disabled, 1= negative speed is enabled if speed mode enabled: 0= positive torque is disabled, 1= positive torque is enabled				0
5.5	Bit	Rx	Pos Torque or Speed	DMC_POS_TRQ_OR_SPD	DMC_CTLB	0	0	1					0
	Bit	Rx			DMC_CTLB	1	7	1					
	Bit	Rx			DMC_CTLB	1	6	1					
	Bit	Rx			DMC_CTLB	1	5	1					
	Bit	Rx			DMC_CTLB	1	4	1					
	Bit	Rx			DMC_CTLB	1	3	1					
	Bit	Rx			DMC_CTLB	1	2	1					
	Bit	Rx			DMC_CTLB	1	1	1					
	Bit	Rx	*CAN request factory info ID 0x212*	*not implemented*	DMC_CTLB	1	0	1	0 =no request, 1 = request factory ID 0x212				
6.0	Sig	Rx	Speed Request	DMC_SPD_REQ	DMC_CTL	2/3	0	2	-32768...+32767	1	rpm	see Comments	0
7.0	Sig	Rx	Torque Request	DMC_TRQ_REQ	DMC_CTL	4/5	0	2	-20...+20	0.01	Nm	see Comments	0
8.0	Sig	Rx	Rotor offset	DMC_TRQ_LIM	DMC_CTL	6/7	0	2	-24...+23	1			0
10.0	Msg	Rx	DMC DC Limits	DMC_DLIM	VBUS	0x211 (0x209)		8		500 + (OC)	11	2000	Use default
11.0	Sig	Rx	Motoring DC Voltage Limit	DMC_DC_VLIMM	DMC_DLIM	0/1	0	2	0...+500	0.1	V		250
11.5	Sig	Rx	Regenerating DC Voltage Limit	DMC_DC_VLIMG	DMC_DLIM	2/3	0	2	0...+500	0.1	V		500
12.0	Sig	Rx	DC Current Limit Motoring	DMC_DC_CLIMM	DMC_DLIM	4/5	0	2	0...+500	0.1	A		20
13.0	Sig	Rx	DC Current Limit Regenerating	DMC_ROT_OFFST	DMC_DLIM	6/7	0	2	0...+500	0.1	A		
20.0	Msg	Tx	DMC Torque Status	DMC_TRQS	VBUS	0x258 (0x25B)		8		10 + (OC)		40	No Operation
21.0	Sig	Tx	Torque Status Bitmap	DMC_STAB	DMC_TRGS	0	0	2					0
22.0	Bit	Tx	Pin Main contactor request	DMC_B_MC_PIN	DMC_STAB	0	7	1	0 = Closing allowed, 1 = Open contactor request				0
	Bit	Tx	Dummy			0	6	1					
	Bit	Tx	Dummy			0	5	1					
	Bit	Tx	Dummy			0	4	1					
	Bit	Tx	Dummy			0	3	1					
	Bit	Tx	Dummy			0	2	1					
23.0	Bit	Tx	DMC General Error Latch	DMC_B_ERR	DMC_STAB	0	1	1	0 = No Error, 1 = Error/failure latched				0
24.0	Bit	Tx	DMC General Warning	DMC_B_WARN	DMC_STAB	0	0	1	0 = No Warning, 1 = Warning active				0
25.0	Bit	Tx	Limit DC Current	DMC_B_CLIM	DMC_STAB	1	7	1	1 = Torque Limited				0
26.0	Bit	Tx	Limit DC Voltage	DMC_B_VLIM	DMC_STAB	1	6	1	1 = Torque Limited				0
27.0	Bit	Tx	Limit Speed	DMC_B_SPD_LIM	DMC_STAB	1	5	1	1 = Torque Limited				0
28.0	Bit	Tx	Limit Temperature	DMC_B_TMP_LIM	DMC_STAB	1	4	1	1 = Torque Limited				0
28.1	Bit	Tx	Limit Ix or Iq Current	DMC_B_IX_LIM	DMC_STAB	1	3	1	1 = Torque Limited				0
	Bit	Tx	Dummy			1	2	1					
	Bit	Tx	Dummy			1	1	1					
	Bit	Tx	Dummy			1	0	1					
28.5	Sig	Tx	Torque available	DMC_TRQ_AVL	DMC_TRGS	2/3	0	2	-20...+20	0.01	Nm		0
29.0	Sig	Tx	Torque actual	DMC_TRQ_ACT	DMC_TRGS	4/5	0	2	-20...+20	0.01	Nm		0
29.5	Sig	Tx	Axle Speed	DMC_SPD_ACT	DMC_ACTV	6/7	0	2	-32768...+32767	1	rpm		0
40.0	Msg	Tx	DMC Actual Values	DMC_ACTV	VBUS	0x259 (0x25C)		8		10 + (OC)		40	No Operation

Views			Naming		Loc.				Definition				
Default Sortierung	Level	Rx, Tx (for DMC)	Message Name	Short Name [max. 8 char]	Used in CAN Bus	ID		DLC		Transmit Time* [ms]	Max. Delay time [ms]	Msg Loss Time* [ms]	No message after init
			Analog Signal / Bitmap Name	Short Name [max. 12 char]	Used in Message	Start Byte	Start Bit	Byte Length	Valid range (physical)	Resolution	Unit	Sign Definitions	Default / Init Value
			Bit Name	Short Name [max. 12 char]	Used in Bitmap	Start Byte	Start Bit	Bit Length	Value Definition				Default / Init Value
			Filters										
43.0	Sig	Tx	DC Bus Voltage	DMC_DC_VACT	DMC_ACTV	0/1	0	2	0...+500	0.1	V		0
44.0	Sig	Tx	DC Current	DMC_DC_CACT	DMC_ACTV	2/3	0	2	0...+500	0.1	A	valid for motoring and regenerating	0
45.0	Sig	Tx	AC Phase Current	DMC_AC_CACT	DMC_ACTV	4/5	0	2	0...500	0.25	A		0
46.0	Sig	Tx	Mechanical Power	DMC_MECH_PWR	DMC_ACTV	6/7	0	2	-131072...+131068	4	W		0
50.0	Msg	Tx	DMC Temp Feedback	DMC_TEMP	VBUS	0x458 (0x459)		8		10 + (OC)		4000	Use default
51.0	Sig	Tx	Inverter Temperature	DMC_PIM_TMP	DMC_TEMP	0/1	0	2	-68.6...+256	0.5	°C		0
52.0	Sig	Tx	Motor Temperature	DMC_MOT_TMP	DMC_TEMP	2/3	0	2	-38.2...+256	0.5	°C		0
53.0	Sig	Tx	Dummy	DMC_MOT_DUM		4/5	0	2					
	Sig	Tx	Dummy			6/7	0	2					
60.0	Msg	Tx	DMC Errors	DMC_ERR	VBUS	0x25A (0x25D)		4		10 + (OC)		N/A	N/A
61.0	Sig	Tx	DMC Error Bitmap	DMC_ERRB	DMC_ERR	0	0	2	4				0
62.0	Bit	Tx	Initialization	DMC_E_OC_INI	DMC_ERRB	0	7	1	1= Error occured or latched				0
63.0	Bit	Tx	DC Overcurrent during operation	DMC_E_OC_OP	DMC_ERRB	0	6	1	1= Error occured or latched				0
64.0	Bit	Tx	DC Overvoltage	DMC_E_OV	DMC_ERRB	0	5	1	1= Error occured or latched				0
65.0	Bit	Tx	DC Undervoltage	DMC_E_UV	DMC_ERRB	0	4	1	1= Error occured or latched				0
66.0	Bit	Tx	Severe Overspeed	DMC_E_OSPD	DMC_ERRB	0	3	1	1= Error occured or latched				0
67.0	Bit	Tx	Severe Overtemperature Motor	DMC_E_OT_MOT	DMC_ERRB	0	2	1	1= Error occured or latched				0
68.0	Bit	Tx	Severe Overtemperature DMC	DMC_E_OT_PIM	DMC_ERRB	0	1	1	1= Error occured or latched				0
69.0	Bit	Tx	CAN Message Main Command	DMC_E_CAN	DMC_ERRB	0	0	1	1= Error occured or latched				0
70.0	Bit	Tx	Gate Unit, Short circuit condition	DMC_E_GU_SC	DMC_ERRB	1	7	1	1= Error occured or latched				0
71.0	Bit	Tx	DC Bus Voltage measurement defect	DMC_VOL_MEAS	DMC_ERRB	1	6	1	1= Error occured or latched				0
	Bit	Tx	Overvoltage Sky Converter		DMC_ERRB	1	5	1	1= Error occured or latched				
	Bit	Tx	Dummy			1	4	1					
	Bit	Tx	Dummy			1	3	1					
	Bit	Tx	Dummy			1	2	1					
	Bit	Tx	Dummy			1	1	1					
	Bit	Tx	Dummy			1	0	1					
80.0	Sig	Tx	DMC Warning Bitmap	DMC_WRNB	DMC_ERR	2	0	2	4				0
81.0	Bit	Tx	Limitation by DC Current	DMC_W_CLIM	DMC_WRNB	2	7	1	1= Warning active				0
82.0	Bit	Tx	Limitation by DC Voltage	DMC_W_VLIM	DMC_WRNB	2	6	1	1= Warning active				0
83.0	Bit	Tx	Limitation by Speed	DMC_W_SPD_LIM	DMC_WRNB	2	5	1	1= Warning active				0
84.0	Bit	Tx	Limitation by Motor Temperature	DMC_W_TM_LIM	DMC_WRNB	2	4	1	1= Warning active				0
85.0	Bit	Tx	Limitation by DMC Temperature	DMC_W_TP_LIM	DMC_WRNB	2	3	1	1= Warning active				0
86.0	Bit	Tx	CAN Message DC Limits lost	DMC_W_CAN	DMC_WRNB	2	2	1	1= Warning active				0
87.0	Bit	Tx	Command out of range	DMC_W_CMDINV	DMC_WRNB	2	1	1	1= Warning active				0
88.0	Bit	Tx	CAN Message Torque Control lost	DMC_MSG_LOSS	DMC_WRNB	2	0	1	1= Warning active				0
89.0	Bit	Tx	Limitation by AC Current	DMC_ACC_LIM	DMC_WRNB	3	7	1	1= Warning active				0
90.0	Bit	Tx	Command out of range DMC Torque Control	DMC_COM_OUT	DMC_WRNB	3	6	1	1= Warning active				0
91.0	Bit	Tx	Command out of range DMC DC Limits	DMC_COM_DCLIM_OUT	DMC_WRNB	3	5	1	1= Warning active				0
100.0	Msg	Tx	PARAM_COM_TX	PARAM_COM_TX	VBUS	0x401		8		>=4ms		N/A	N/A
110.0	Msg	Rx	PARAM_COM_RX	PARAM_COM_RX	VBUS	0x400		8		>=4ms		N/A	N/A

11 Operation of the device



- Precharge the high voltage before closing the connections by contactors.
- Connect the pin **EN** to **AUX** (activate ignition key, close switch).
- The CAN – user interface (CVI) can be provided optionally by BRUSA, if the device will not be integrated in an anyway existing CAN-communication network. Such an example is shown on the picture on the left side, whereas the device has to be started as follows:

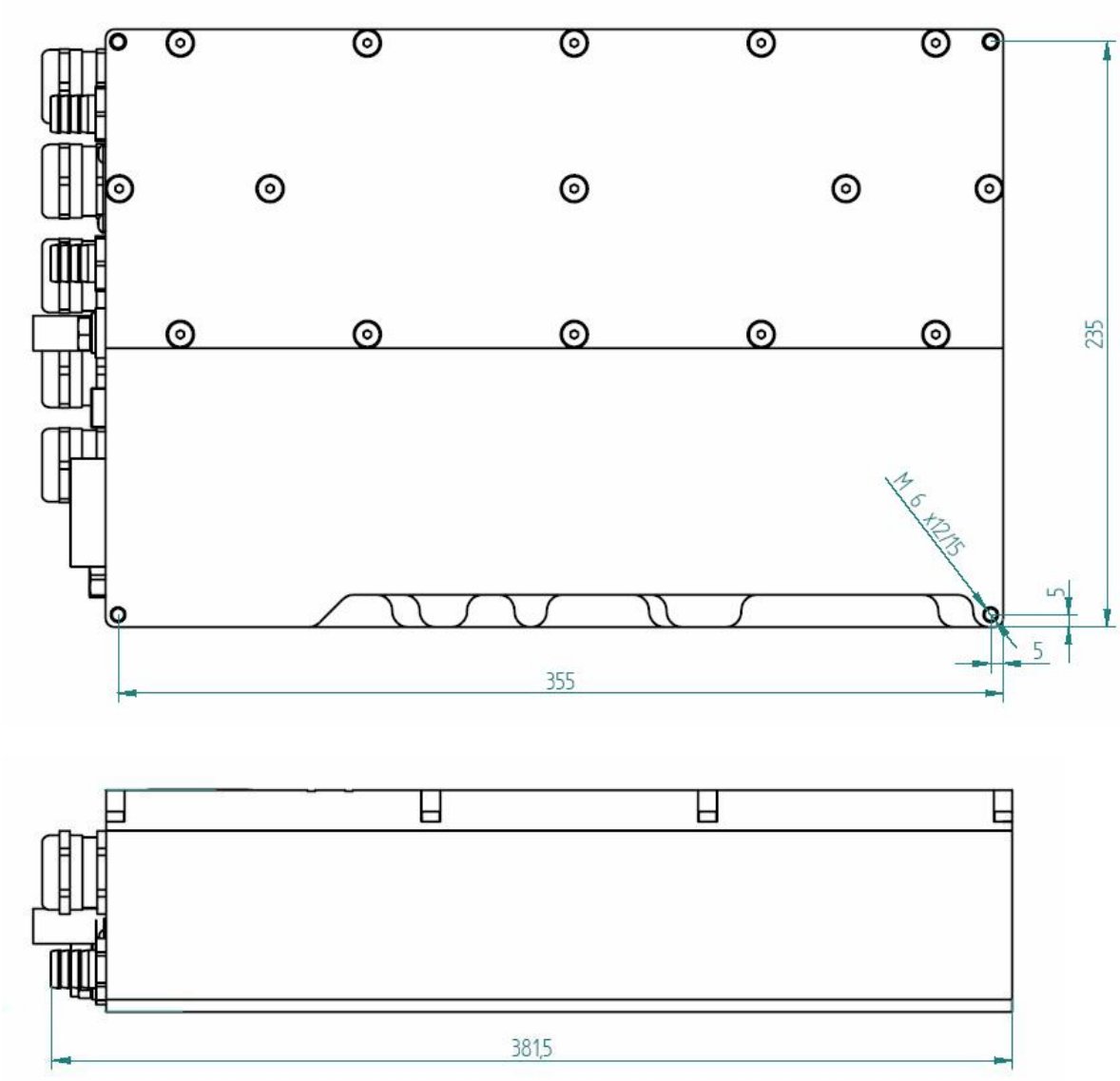
- *Start the CAN – user interface and press the "Start"-button in order to allow communication with the device. With the button "Run" like described in the picture the power stage is activated.*
- *Communication with the device is ensured, if the displays "Tx" and "Rx" are blinking.*

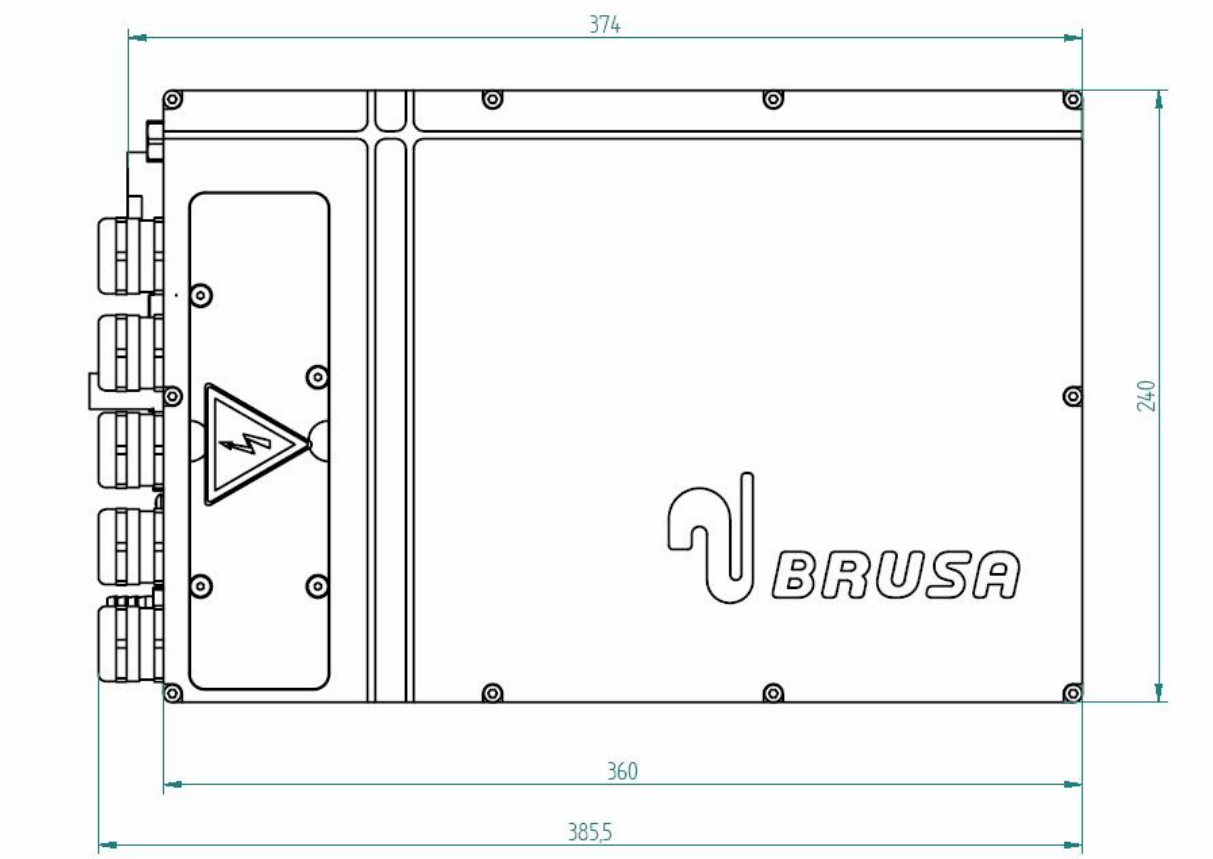
- In order to allow the main regulator to fulfill its function ensure that no limiting regulator is active.
-
- The device can be switched off in any operational condition by pressing again the button "Run" and deactivating the pin **EN**.
- The sudden disconnection of the high voltage (open the contactors) is permissible as well.

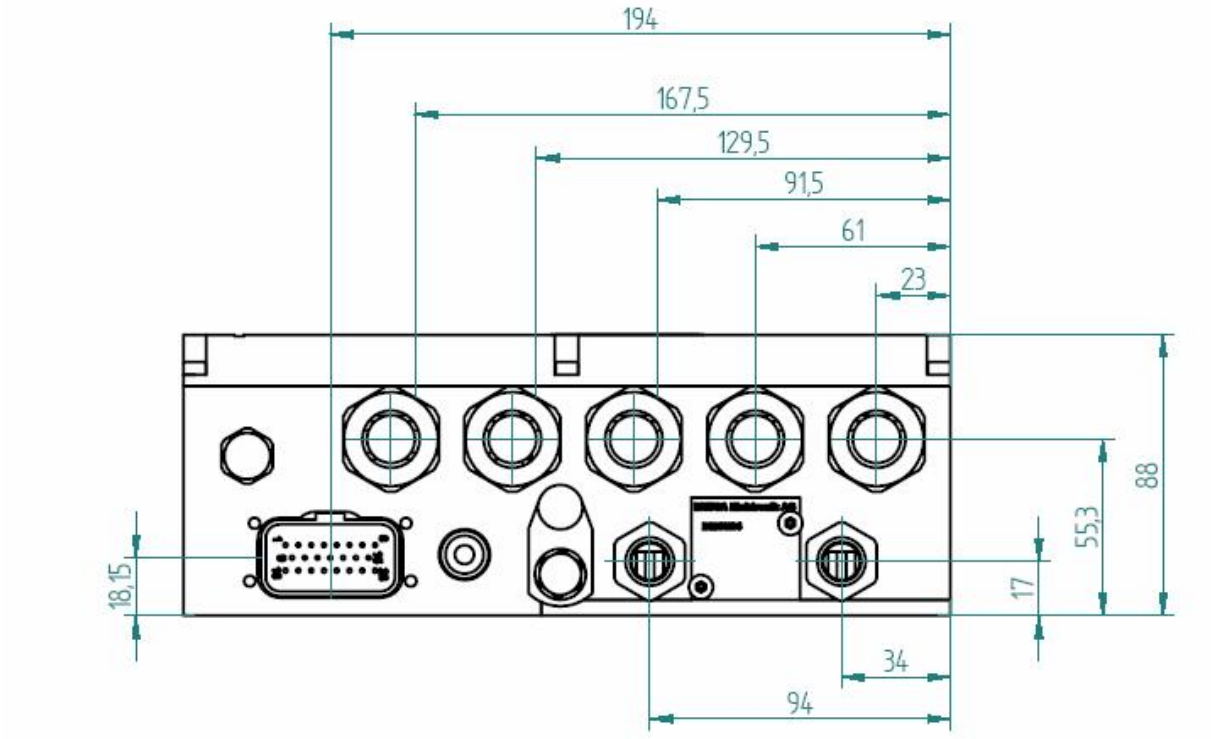
12 Technical Data

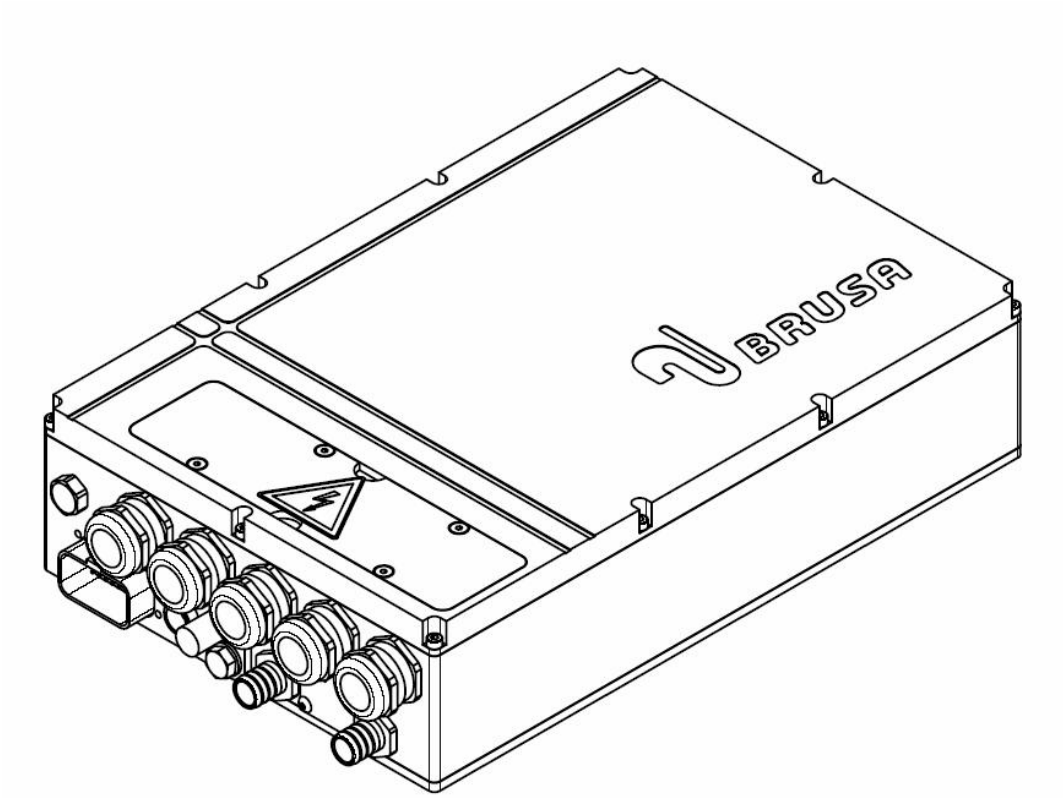
12.1 Mechanic Data

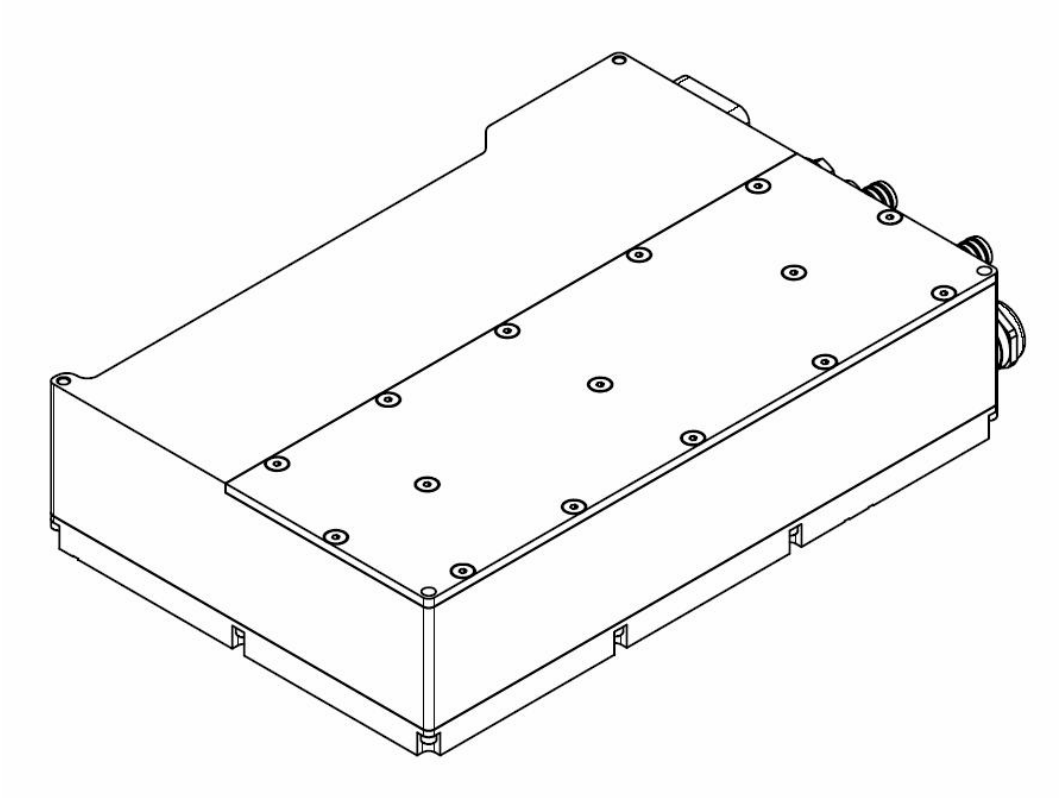
Dimensions with connector (l x w x h):	360mm x 240mm x 88mm
Weight (without cooling water):	9.2 kg
Operating temperature range	-20 – +85 °C
Max. temperature cooling water input:	72 °C
Pressure Loss of cooling medium:	65mbar, Water-Glykol 50/50, T= 25°C, 6l/min
Max. pressure cooling water (at 20°C):	1,0 bar




374
240
BRUSA
360
385,5


194
167,5
129,5
91,5
61
23
88
55,3
17
18,15
34
94


BRUSA



12.2 Electronic Data

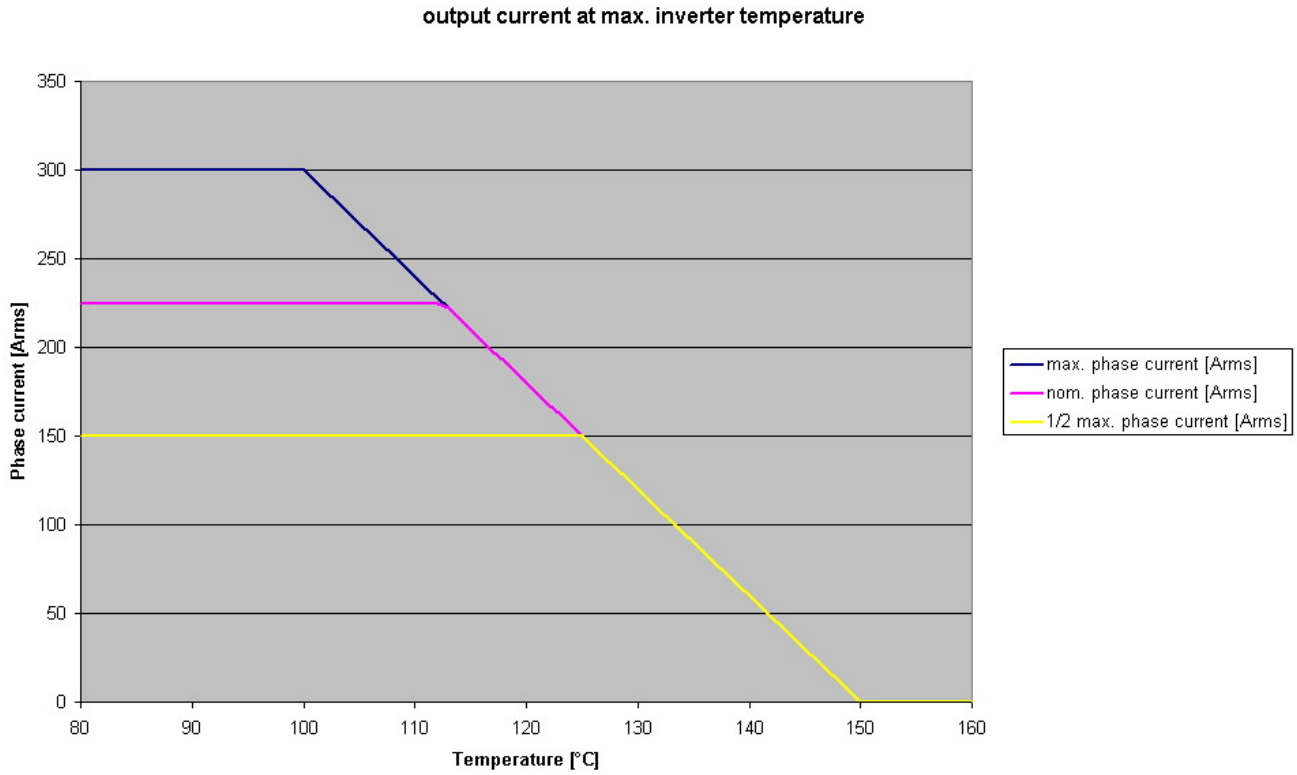
HV voltage range: (HVDC)	120 – 480VDC
LV supply range	8,0 – 30,0VDC
Max. current HV (max. power):	300A
Standby current HV (without torque)	100mA @ 360V HVDC
Max. induced Motor voltage phase to phase @ 400V HV	224VAC
Max. output AC phase current:	$300A_{RMS}$
Continuous AC phase current @ 360 V, $T_{coolant}$ = 72°C	$225A_{RMS}$
Max. output power @ 360V	106kVA
Continuous appearent output power @ 360V, $T_{coolant}$ = 72 °C	80kVA
Motor frequency:	0 – 2'000Hz
PWM switching frequency:	23.4375kHz

Temperature limits: (default value)*	
Maximum Inverter Temperature	150°C
Reduction of output current with rising temperature of Inverter:	-6A/°C

See also diagram: 12.3.1, Output current

12.3 Diagrams

12.3.1 Output current



13 Warranty

- We assure a warranty for a period of 24 month from the date of purchase for defects of material and by workmanship.
- Improper use or handling of the product causes the warranty to be void.
- Specifications are subject to change without notice.
- Note that this device processes lethal voltages. We cannot accept any liability concerning this danger.
- We cannot accept any liability for consequential damages which arose from the use of this device.